POLE VIBRATION DAMPING ASSEMBLY AND METHOD

BACKGROUND OF THE INVENTION

1. FIELD OF THE INVENTION

The present invention relates to a vibration damping apparatus and methods. More specifically, the invention relates to vibration damping apparatus and methods for reducing wind induced vibration of light poles, flag poles and the like.

Light poles and similar devices are subject to wind induced vibrations which can result in costly and hazardous failures of such structures. Many parameters including pole geometry and materials, wind speed, wind gust frequency and velocity are involved in effecting pole vibration. For many years those of skill in the art were of the belief that second harmonic mode vibrations were solely responsible for structural failures of poles and vibration dampers such as that shown in applicant's U.S. Patent No. 3,612,222 were designed so as to reduce second harmonic mode vibration. Second harmonic mode vibration of poles is generally considered to be of approximately four cycles of vibration per second. However, within recent years a number of pole failures have occurred which were not caused by second harmonic mode vibrations but were resultant from first harmonic mode vibrations which occurred at a frequency of approximately one vibration cycle per second.

The present invention in one aspect is directed to vibration dampers for poles capable of reducing first mode natural frequency vibrations.

2. RELATED ART

The prior art is replete with devices and methods intended to reduce pole vibration as exemplified by the following discussed prior art patents.

Applicant's earlier U.S. Patent No. 3,612,222 discloses a pole-mounted second mode natural frequency vibration damping assembly employing a metal rod loosely fitted in a tubular member attached to the pole.

Feldberg U.S. Patent No. 6,234,286 purports to be an improvement over applicant's earlier U.S. Patent No. 3,612,222 with respect to which it differs only in a minor manner relating to the attachment of the device to a pole.

Kemeny U.S. Patent No. 6,035,981 discloses a complicated broadband passive mass damper intended for use on machinery or other equipment.

Aida *et al.* U.S. Patent No. 5,896,961 discloses a dynamic vibration absorber mounted on a light pole by a variety of magnetic devices.

Phillips *et al.* U.S. Patent No. 5,682,069 discloses a vibration damping assembly mounted on a strut about which the device surrounds.

Hamada *et al.* U.S. Patent No. 5,593,144 discloses a vibration damping device mounted on a drive shaft.

Knodo *et al.* U.S. Patent No. 4,736,701 discloses a variety of devices for attachment to the upper end of a mast.

Lehmann *et al.* U.S. Patent No. 4,640.216 is directed to a vibration damping assembly for a periscope.

Buckley U.S. Patent No. 4,350,233 discloses a vibration damping device provided internally of a pole or the like effecting first harmonic mode vibration damping.

Reed U.S. Patent No. 3,568,803 discloses a vibration damping device attached to the upper end of a mast.

Reutlinger U.S. Patent No. 3,382,629 discloses a vibration damping assembly attached to a mast or pole.

Nishioka *et al.* U.S. Patent No. 3,259,212 discloses a pole vibration damping device mounted on the outer end of a curved pole.

Chen U.S. Patent No. 3,245,177 is directed to a vibration damping device for reducing vibrations of a chimney or the like by the use of porous, loose fill material and liquid.

Chen U.S. Patent No. 3,174,589 is similar to the above-noted U.S. Patent No. 3,245,177.

SUMMARY OF THE INVENTION

The primary object of the present invention is the provision of pole vibration dampers for reducing first harmonic mode vibrations.

A further object of the present invention is the provision of pole first mode vibration dampers capable of operating in conjunction with second harmonic mode vibration dampers of the same pole.

The present invention achieves the foregoing objects by the provision of an annular hollow housing having an axially positioned cylindrical opening dimensioned to matingly fit over a pole upper end portion. The annular housing has a an annular interior chamber which is divided into a plurality of discreet chambers extending about the entire periphery of the housing with each chamber enclosing a single spherical lead weight. The weights act in harmony to reduce first mode harmonic vibration. The first mode harmonic vibration damper acts in conjunction with a second mode vibration damper provided in the mid-portion of the pole so as to reduce vibration and preclude structural failure caused by either first or second mode vibration.

Other objects, features and advantages of the present invention will be apparent to those skilled in the art upon a reading of this specification including the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is better understood by reference to the following Detailed Description of the Preferred Embodiments with reference to the accompanying drawing figures, in which like reference numerals refer to like elements throughout, and in which:

Figure 1 is a front elevation view of a light pole on which the preferred embodiment first harmonic mode damping apparatus is positioned;

Figure 2 is a perspective view of a preferred embodiment of a half-portion housing of the first harmonic mode vibration damping device;

Figure 3 is a top plan view of a half-portion housing of Figure 2;

Figure 4 is a front elevation view of the half-portion housing of the Figure 3;

Figure 5 is a rear elevation view of the half-portion housing of Figure 3;

Figure 6 is a right side elevation view of the half-portion housing of Figure 3;

Figure 7 is a sectional view taken along line 7-7 of Figure 3;

Figure 8 is a sectional view taken along line 8-8 of Figure 3;

Figure 9 is an enlarged view of the encircled portion 9 in Figure 3;

Figure 10 is an enlarged view of the encircled portion 10 in Figure 3;

Figure 11 is an enlarged view of the encircled portion 11 in Figure 3;

Figure 12 is a section view taken along line 12-12 of Figure 3;

Figure 13 is an enlarged view of the encircled portion 13 in Figure 3;

Figure 14 is an enlarged view of the encircled portion 14 in Figure 3;

Figure 15 is a section view taken along line 15-15 of Figure 3;

Figure 16 is a top plan view of the preferred embodiment first harmonic mode vibration damper with the top cover components removed;

Figure 17 is a front elevation view of the preferred embodiment of Figure 16;

Figure 18 is a top plan view of the preferred embodiment of figure 16 with the top cover components in position;

Figure 19 is a perspective view of the preferred embodiment with the cover components removed; and

Figure 20 is a perspective view of the cover components

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

In describing the following embodiments of the present invention illustrated in the drawings, specific terminology is employed for the sake of clarity. However, the invention is not intended to be limited to the specific terminology so selected, and it is to be understood that each specific element includes all technical equivalents that operate in a similar manner to accomplish a similar purpose.

The preferred embodiment 20 of the invention comprises a first harmonic mode vibration damper which in use is mounted on a pole P in an upper position thereof as shown in Figure 1. It should be noted that the preferred embodiment 20 is mounted at the upper end of pole P adjacent a mounting fitting in the form of a pipe 121 or the like of conventional construction and to which a light or other device is conventionally mounted when the pole is in use. It should also be noted that a conventional second harmonic mode vibration damper 21 of the type disclosed in U.S. Patent No. 3,612,222 is mounted in the mid-portion of pole P.

The primary components of the preferred embodiment 20 comprise first and second housing component half-portions 22 and 24 respectively each of which is formed of cast aluminum. The first housing component half-portion 22 and second housing component half-portion 24 are identical and are associated together to form a unitary housing structure 54 as shown in Figures 16 and 19. The first housing component half-portion 22 will be described in detail and it should be understood that such description is equally applicable to the second housing component half-portion 24. The numerical designators applied to second housing component half-portion 24 in the drawings correspond to those of first housing component half-portion 22 but are primed for the sake of clarity.

Housing component half-portion 22 has a vertical height of three (3) inches and includes an inner partial cylinder surface 26 (Figure 2) having a radius of approximately three (3) inches which blends into an inner planar surface 28 of a first panel plate 25 having an outer end terminating at a connector lug 29 having threaded bore openings 31 as shown in Figure 2. The opposite end of the inner partial cylinder surface 26 terminates at a juncture lug 27 connected to the inner end of a second panel plate 30. The outer end of the second panel plate 30 terminates in an outer connector lug 32 which has smooth bore holes 58 usable for connecting the first housing component half-portion 22 to the connector lug 29′ of second housing component half-portion 24 in a manner to be discussed. Connector lug 32 is also connected to one end of an outer partial cylindrical outer sleeve 34 having an inner surface 36 having a radius of eight (8) inches. Sleeve 34 is of cylindrical configuration and having a center of curvature coextensive with the center of curvature of the inner partial cylinder surface 26. The opposite end of outer sleeve 34 merges into the connector lug portion 29 as best shown in Figures 2 and 16.

Internal positioning panels 38 and 40 extend chordally relative to sleeve 34 and surface 26 internally of the first housing component half-portion 22 between the inner surface of the outer partial cylindrical sleeve 34 and the outer surface of the inner partial cylinder surface 26 so as to divide the interior of first half-housing component 22 into damping weight receiving chambers 42, 44 and 46 each having floor portions 50 and walls oriented 60° relative to each other. A spherical damping weight 48 formed of lead and having a diameter of approximately 2.1875 inches is provided in each weight receiving chamber. The damping weights 48 could also be formed of other heavy metal material or could comprise lead or other metal spheres covered with a polyurethane coating.

The upper and lower threaded apertures 31 in lug portion 29 of first housing component half-portion 22 are alignable with bore holes 58′ in connector lug 32′ (Figure 19) of second housing component half-portion 24 so that machine screws 60 can be inserted through bore holes 58′ and into threaded apertures 31 for effecting connection of the aligned components 29 and 32 as shown in Figure 16.

Similarly, bore holes 58 in connector lug 32 of portion 22 are alignable with threaded apertures 31′ in the lug portion 29′ of the second housing component half-portion 24. Tightening of the aforementioned machine screws acts to clamp the annular composite assembly consisting of items 22 and 24 as shown in Figure 16 of the pole P positioned between surfaces 26 and 26′ in an obvious manner.

Completion of the mounting of the assembly on the cylindrical upper end surface of the pole is effected by positioning of metal cover portions 222 and 224 on top of half-portions 22 and 24. The cover portions 222 and 224 are then respectively connected to half-portions 22 and 24 structure by metal screws passing through apertures 223 provided therein to enter threaded bores 250 in the half-portions. The completed assembly is then mounted on the cylindrical upper end surface of the pole.

Modifications and variations of the above-described embodiments of the present invention are possible, such as different dimensions and equivalent structure as appreciated by those skilled in the art in light of the above teachings. It is therefore to be understood that, within the scope of the appended claims and their equivalents, the invention may be practiced otherwise than as specifically described.